

WHAT IS CLAIMED IS:

- 1        1.        A dual current-perpendicular-to-plane (CPP) GMR sensor, comprising:
  - 2              a first magnetic shield formed of an electrically conductive and magnetically
  - 3              shielding material;
  - 4              a second magnetic shield formed of an electrically conductive and magnetically
  - 5              shielding material, the first and the second magnetic shields disposed to define a read gap
  - 6              therebetween;
  - 7              a spin valve structure disposed between the first and second magnetic shields, the
  - 8              spin valve structure including a dual spin valve arrangement, the dual spin valve
  - 9              arrangement having a top and bottom spin self-pinned layer and a free ferromagnetic
  - 10          layers disposed therebetween; and
  - 11          a biasing layer disposed proximate the top self-pinned layer in a passive region
  - 12          for pinning the top self-pinned layer.
- 1        2.        The dual CPP GMR sensor of claim 1 further comprising:
  - 2              a hard bias layer disposed proximate the bottom self-pinned layer in a passive
  - 3              region for biasing the bottom self-pinned layer;
  - 4              a first metal oxide layer disposed between the biasing layer and the hard bias layer
  - 5              for providing an insulation layer to the hard bias layer; and
  - 6              a second metal oxide layer formed above the biasing layer.

1           3.       The dual CPP GMR sensor of claim 2 further comprising a second metal  
2       oxide layer formed above the biasing layer.

1           4.       The dual CPP GMR sensor of claim 3, wherein the metal oxide layers  
2       further comprises NiO.

1           5.       The dual CPP GMR sensor of claim 3 further comprises a ferromagnetic  
2       layer disposed over the second metal oxide layer and the self-pinned layer, wherein the  
3       second metal oxide layer removes exchange coupling to the hard bias layer.

1           6.       The dual CPP GMR sensor of claim 5 further comprising a Ta layer  
2       formed between the ferromagnetic layer and the second shield.

1           7.       The dual CPP GMR sensor of claim 6, wherein the ferromagnetic layer  
2       comprises NiFe.

1           8.       The dual CPP GMR sensor of claim 1 further comprising a first and  
2       second metal oxide layer formed under and above the biasing layer.

1           9.       The dual CPP GMR sensor of claim 8, wherein the metal oxide layers  
2       further comprises NiO.

1           10.     The dual CPP GMR sensor of claim 9 further comprises a ferromagnetic  
2     layer disposed below the second shield and over the second metal oxide layer and the  
3     self-pinned layer, wherein the second metal oxide layer removes exchange coupling to  
4     the hard bias layer.

1           11.     The dual CPP GMR sensor of claim 10 further comprising a Ta layer  
2     formed between the ferromagnetic layer and the second shield.

1           12.     The dual CPP GMR sensor of claim 10, wherein the ferromagnetic layer  
2     comprises NiFe.

1           13.     The dual CPP GMR sensor of claim 1, wherein the first and second shields  
2     function as electrodes for supplying current to the spin valve structure.

1           14.     The dual CPP GMR sensor of claim 1, wherein the biasing layer  
2     comprises a layer of alpha- $\text{Fe}_2\text{O}_3$ , the layer of alpha- $\text{Fe}_2\text{O}_3$  pinning the top self-pinned  
3     layer.

1           15.     The dual CPP GMR sensor of claim 1, wherein the layer of alpha- $\text{Fe}_2\text{O}_3$   
2     pins the top portion of the top self-pinned layer by providing higher coercivity ( $H_C$ ) to the  
3     top self-pinned layer.

1           16. A magnetic storage system, comprising:

2           a magnetic storage medium having a plurality of tracks for recording of data; and

3           a dual CPP GMR sensor maintained in a closely spaced position relative to the

4           magnetic storage medium during relative motion between the magnetic transducer and

5           the magnetic storage medium, the dual CPP GMR sensor further comprising:

6                 a first magnetic shield formed of an electrically conductive and

7                 magnetically shielding material;

8                 a second magnetic shield formed of an electrically conductive and

9                 magnetically shielding material, the first and the second magnetic shields disposed to

10          define a read gap therebetween;

11                 a spin valve structure disposed between the first and second magnetic

12          shields, the spin valve structure including a dual spin valve arrangement, the dual spin

13          valve arrangement having a top and bottom spin self-pinned layer and a free

14          ferromagnetic layers disposed therebetween; and

15                 a biasing layer disposed proximate the top self-pinned layer in a passive

16          region for pinning the top self-pinned layer.

1           17.     The magnetic storage system of claim 16, wherein the CPP GMR sensor  
2 further comprises:

3                 a hard bias layer disposed proximate the bottom self-pinned layer in a passive  
4 region for biasing the bottom self-pinned layer;  
5                 a first metal oxide layer disposed between the biasing layer and the hard bias layer  
6 for providing an insulation layer to the hard bias layer; and  
7                 a second metal oxide layer formed above the biasing layer.

1           18.     The magnetic storage system of claim 17, wherein the CPP GMR sensor  
2 further comprises a second metal oxide layer formed above the biasing layer.

1           19.     The magnetic storage system of claim 18, wherein the metal oxide layers  
2 further comprises NiO.

1           20.     The magnetic storage system of claim 18, wherein the CPP GMR sensor  
2 further comprises a ferromagnetic layer disposed over the second metal oxide layer and  
3 the self-pinned layer, wherein the second metal oxide layer removes exchange coupling  
4 to the hard bias layer.

1           21.     The magnetic storage system of claim 20, wherein the CPP GMR sensor  
2 further comprises a Ta layer formed between the ferromagnetic layer and the second  
3 shield.

1           22.     The magnetic storage system of claim 21, wherein the ferromagnetic layer  
2     comprises NiFe.

1           23.     The magnetic storage system of claim 16, wherein the CPP GMR sensor  
2     further comprises a first and second metal oxide layer formed under and above the  
3     biasing layer.

1           24.     The magnetic storage system of claim 23, wherein the metal oxide layers  
2     further comprises NiO.

1           25.     The magnetic storage system of claim 24, wherein the CPP GMR sensor  
2     further comprises further comprises a ferromagnetic layer disposed below the second  
3     shield and over the second metal oxide layer and the self-pinned layer, wherein the  
4     second metal oxide layer removes exchange coupling to the hard bias layer.

1           26.     The magnetic storage system of claim 25, wherein the CPP GMR sensor  
2     further comprises a Ta layer formed between the ferromagnetic layer and the second  
3     shield.

1           27.     The magnetic storage system of claim 25, wherein the ferromagnetic layer  
2     comprises NiFe.

1           28.     The magnetic storage system of claim 16, wherein the first and second  
2     shields function as electrodes for supplying current to the spin valve structure.

1           29.     The magnetic storage system of claim 16, wherein the biasing layer  
2     comprises a layer of alpha-Fe<sub>2</sub>O<sub>3</sub>, the layer of alpha-Fe<sub>2</sub>O<sub>3</sub> pinning the top self-pinned  
3     layer.

1           30.     The magnetic storage system of claim 16, wherein the layer of  
2     alpha-Fe<sub>2</sub>O<sub>3</sub> pins the top portion of the top self-pinned layer by providing higher  
3     coercivity (H<sub>C</sub>) to the top self-pinned layer.

1           31.     A method for providing a dual current-perpendicular-to-plane (CPP) GMR  
2     sensor with improved top pinning, comprising:

3                 forming a first magnetic shield of an electrically conductive and magnetically  
4     shielding material;

5                 forming a second magnetic shield of an electrically conductive and magnetically  
6     shielding material, the first and the second magnetic shields disposed to define a read gap  
7     therebetween;

8                 forming a spin valve structure between the first and second magnetic shields, the  
9     spin valve structure including a dual spin valve arrangement, the dual spin valve  
10   arrangement having a top and bottom spin self-pinned layer and a free ferromagnetic  
11   layers disposed therebetween; and

12                 forming a biasing layer disposed proximate the top self-pinned layer in a passive  
13   region for pinning the top self-pinned layer.

1           32.     The method of claim 31 further comprising:  
2                 forming a hard bias layer proximate the bottom self-pinned layer in a passive  
3     region for biasing the bottom self-pinned layer;  
4                 forming a first metal oxide layer between the biasing layer and the hard bias layer  
5     for providing an insulation layer to the hard bias layer; and  
6                 forming a second metal oxide layer above the biasing layer.

1           33.     The method of claim 2 further comprising forming a second metal oxide  
2     layer above the biasing layer.

1           34.     The method of claim 3 further comprises forming a ferromagnetic layer  
2     over the second metal oxide layer and the self-pinned layer, wherein the second metal  
3     oxide layer removes exchange coupling to the hard bias layer.

1           35.     The method of claim 5 further comprising forming a Ta layer between the  
2     ferromagnetic layer and the second shield.